whereas body weight and tarsus length did not differ significantly between the sexes. Between adults and juveniles, bill and tail lengths were significantly longer in adults, but there was no significant difference in the other 3 characters. Overall size dimorphism was tested with the MANOVA programme of Cooley & Lohnes (1971), and this revealed a distinct size dimorphism between males and females and between adults and juveniles, with males significantly larger than females and adults larger than juveniles in overall body size (Table 2).

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Spurs and their function in some female game-birds

by G. W. H. Davison

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Although Galliformes' weaponry is confined to a single type – leg spurs –, there is a wide range in spur representation and number on the 2 sexes. There are 96 species with spurs only in males, and 17 with spurs normally in both sexes (Davison 1985). Spurs of males are always as large as or larger than those of females of equivalent age. The question then arises whether females' weaponry is adaptive, or represents incomplete suppression of the genotype for a feature which is non functional in that sex (cf. Kiltie 1985).

All species with multiple spurs show great variability in spur number, which is likely to be reflected by individual variation in wound inflicting ability. It is the purpose of this note to examine spur number and its variation, with special reference to females of some multiple spurred species. Statistical tests follow Conover (1980).

ITHAGINIS CRUENTUS

Table 1 shows the distribution of spur number in 4 age and sex classes of *I. cruentus,* as shown by museum skins. First-year birds were identified by their retention of 2 unmoulted juvenile primaries, accompanied in males by yellowish (not grey) abdomen and vermiculated (not striped) thighs.

TABLE 1

Representation by spur number (summed on the 2 legs) of age and sex classes of *Ithaginis cruentus, Galloperdix spadicea* and *G. lunulata*

	Total spur number							
	0	1	2	3	4	5	6	n
				Ithaginis cruentus				
Male adult	3	1	2	5	45	13	5	74
Male 1st year	13	–	1	2	7	1	–	24
Female adult	27	3	6	3	1	–	–	40
Female 1st year	8	2	–	–	–	–	–	10
				Galloperdix spadicea				
Male adult	–	–	1	1	39	2	–	43
Male 1st year	3	–	1	1	5	–	–	10
Female adult	–	1	5	6	9	–	–	21
Female 1st year	4	1	–	4	2	–	–	11
				Galloperdix lunulata				
Male adult	–	–	1	2	27	1	–	31
Female adult	2	–	5	5	7	1	–	20
Female 1st year	2	–	–	1	–	1	–	4

Spur number is apparently bimodal in 3 of the 4 classes, the exception being first year females. All but 3 adult males had spurs. Nearly half of all males in first year plumage had spurs, and the relative size of the peaks in these 2 classes suggests that some males develop spurs while in first year plumage, others only after assumption of adult plumage. The 3 spurless adult males, therefore, might have developed spurs had they lived longer. Of adult females one third were spurred, but spur number was bimodal at 0 or 2 (compared with 0 or 4 in males). Spur number was no more variable in females than in males. That spur number in first year females was unimodal suggests that spurs develop later, relative to the post juvenile moult, in females than in males. Again, some of the spurless females might have developed spurs later had they lived.

Wing length and spur number were independent: in the full sample of adult males (Spearman $r_s = 0.267$, $p > 0.05$), in spurred adult females ($r_s = 0.368$, $n = 12$, $p > 0.10$), and in spurred first year males ($r_s = -0.036$, $n = 8$, $p > 0.10$). But spurred adult females as a whole were significantly longer-winged than spurless adult females (Wilcoxon $Z = 2.248$, $p = 0.012$). Out of 34 females in adult plumage, the 11 smallest were all spurless. Perhaps females become larger and develop spurs in old age, or perhaps only large females have the capacity for spur development. Whichever is true, the factor which determines spur growth is linked with size, and is independent of the factor which determines spur number.

GALLOPERDIX SPADICEA

In this species (Table 1) all adult males and females were spurred. In both sexes, over half the first year birds were already spurred, suggesting that spur growth is earlier relative to plumage change in this species than in *Ithaginis* *cruentus.* Spur number in adult males was unimodal at 4, with a clear peak, and was also unimodal at 4 but with a broader peak in females. In other words, the distribution of spur number among males is leptokurtic, but in females it is platykurtic. These are further differences from *I. cruentus.*

GALLOPERDIX LUNULATA

This species closely resembles *G. spadicea,* except that spur growth may occur slightly later (witness 2 still spurless adult females – Table 1). Like *G. spadicea,* spur number was similar in the 2 sexes, with a more platykurtic distribution in females.

Discussion

The above figures give no definite answer to the question of adaptiveness of spurs in females, but they give some clues, especially in relation to spurredness in females of other species.

Presence or absence of spurs in females is related to spur number in the equivalent males. Thus females bear spurs in only 12.5% of the 80 species in which males are single spurred, but in 27.3% of the 33 species in which males are multiple spurred (Davison 1985). There are striking differences in female spurredness between closely related species. Female *Pavo muticus* are spurred but female *P. cristatus* are not. Female *Lophura erythrophthalma* are spurred, but females of 9 congeners are not (Delacour 1977). *P. muticus* and *L. erythrophthalma* are also peculiar within their respective genera in that females bear 'male-like' iridescent plumage.

Female spurredness is related to the social system. Males of 6 polygynous species have multiple spurs and their females are all spurless. Males of 25 polygynous species have single spurs, and in only 2 (8%) are their females spurred. This contrasts with the case amongst monogamous Galliformes, among which females of 14.5% of the 55 single spurred, and 33.3% of the 27 multiple spurred species, are themselves spurred. Thus, whereas in males spurredness is more strongly associated with polygyny (94% of males spurred) than with monogamy (63.2% of males spurred), in females it is the reverse.

Consideration of *Galloperdix* and *Ithaginis* resolves this seeming anomaly. Species of *Galloperdix* are apparently monogamous, the 2 sexes indulging in joint territorial defence by fighting and mutual calling (Henry 1978, Ali & Ripley 1969). Equal spur number in the 2 sexes, with all or nearly all adult females spurred, can be seen to reflect similar investment in territorial defence prior to nesting by the 2 members of the pair. Even so, a more even spread in spur number in females than in males suggests less intense selection pressure in that sex (see Kiltie 1985).

Polygyny, polyandry and monogamy have all been suggested as components of the social system of *Ithaginis* (Hume & Marshall 1879, Baker 1928, Grahame 1971). Very large flocks form in winter (Hume & Marshall 1879), and these break up into loosely associated pairs (Grahame 1976). Perhaps within winter flocks there is local mate competition between females as well as between males. If so, larger (and older?) females which have developed spurs should hold an advantage.

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Polymorphic rectrix number and ocellus size in *Polyplectron*

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Cases of polymorphism involving distinct plumage colour are rare amongst Galliformes; male *Pucrasia macrolopha* (breast colour) and *Polyplectron emphanum* (brow colour) are examples (Delacour 1977). Much more common is polymorphism in spur number, amongst species with multiple spurs (Davison 1985a), and in tail feather number, as in Tetraonidae. Male *Dendragapus obscurus* have from 8 to 11 pairs of rectrices, and male *Bonasa umbellus* 7 to 10 pairs (Short 1967).

One group in which spur number is highly variable within species is *Polyplectron,* the peacock pheasants (Davison 1985b). In that genus few-spurred males are generally small, with absolutely and relatively short tails. Spur number and size might influence fighting ability, yet in the sample sizes used by Davison there was no clear correlation between a major visual component of display, namely the ocelli, and either size or spur number. This paper therefore reconsiders the above features in relation to rectrix number, another polymorphic feature of the genus not yet investigated.

The specimens used by Davison (1985b) were re-examined, and rectrix number counted on each. Care was taken to include feather positions undergoing moult. An additional 11 adult male *P. bicalcaratum bakeri* were measured for all characters (wing and tail lengths, largest wing ocellus and largest tail ocellus dimensions, rectrix number and spur number), representing a 60% increase in sample size for this subspecies. Correlations between ocellus size and other physical characters were re-tested using this expanded sample.

Table 1 shows the range in number of rectrices for the 2 sexes of all *Polyplectron* species. The data suggest that 8 pairs is the primitive number within the genus. This is the number in both sexes of *P. chalcurum,* generally considered the most primitive species (Delacour 1977, Geist 1977), and in females of some others. In other species, rectrix number is greater and more variable in males than in females.